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COVID-19 outbreaks in long-term care facilities—a nationwide population-based cohort study in Taiwan, May–July 2021

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*AUTHORSHIP* All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated sufficiently in the work to take public responsibility for the content, including participation in the concept, design, analysis, writing, or revision of the manuscript. Furthermore, each author certifies that this material or similar material has not been and will not be submitted to or published in any other publication.

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# COVID-19 outbreaks in long-term care facilities—a nationwide population-based cohort study in Taiwan, May–July 2021

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# All authors declare no conflicts of interest to disclose.

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## Abstract

*Background/Purpose*: Long-term care facilities (LTCFs) are high-risk settings for the novel coronavirus disease (COVID-19). The aim of the study was to describe the extent and the impacts of 2021 COVID-19 outbreaks on LTCFs in Taiwan.

*Methods*: We retrospectively analyzed the data of each COVID-19 outbreak in LTCFs from May 15 to July 31, 2021 in Taiwan. We characterized the features of LTCFs with outbreaks and compared the characteristics of infected staff members and residents of the affected LTCFs.

*Results*: COVID-19 outbreaks were reported in 16 LTCFs (0.9%). The outbreak was significantly associated with LTCFs with ≥50 beds [adjusted odds ratio (aOR), 6.3; 95%confidence interval [CI], 1.9–21.1] and location of Taipei metropolitan area(aOR, 4.6; 95%CI, 1.7–12.8). Resident cases accounted for 75.4% (203/269) of confirmed cases affected by outbreaks. The 30-day all-cause mortality was 24.2% for residents only and was significantly associated with age ≥65 years [adjusted hazard ratio (aHR, 4.3; 95%CI, 1.7–10.5)], presence of symptoms on diagnosis (aHR, 2.2; 95%CI, 1.3–3.7), and LTCF occupancy rate ≥80% (aHR, 3.0, 95%CI, 1.3–7.4).

*Conclusion*: COVID-19 outbreaks have a critical impact on residents in LTCFs owing to the advanced age and high prevalence of chronic comorbidities in this population. Multi-pronged infection control measures and mass testing are vital for mitigating COVID-19 transmission in LTCFs.


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## Keywords

Long-term care facility; Outbreak; COVID-19

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## Introduction

Residents in long-term care facilities (LTCF) have been disproportionately affected by the novel coronavirus disease (COVID-19), which is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), owing to their older age and high prevalence of chronic medical conditions in this patient population.[1-6] Living in LTCFs is also a significant risk factor for COVID-19 mortality,[3,4,7] and LTCFs have become a common source of COVID-19 outbreaks.[1,2,8,9]

These facts underscore the importance of infection prevention and control (IPC) practices and mitigation measures to prevent COVID-19 outbreaks and prevent the extension of outbreaks that emerge in LTCFs in addition to pharmaceutical interventions for the patients.[7,9-11] However, preventing COVID-19 outbreaks in LTCFs is a unique challenge due to the infectivity of the SARS-CoV-2 prior to the onset of symptoms and difficulty in adherence to IPC measures among residents with compromised cognition and disabilities.[3,7,12]

Before May 2021, no COVID-19 outbreak was reported in any of the LTCFs in Taiwan, except for a case report in which only one nurse working at a nursing home tested positive for SARS-CoV-2, without inducing a subsequent outbreak event in the facility she served.[13] Nevertheless, the number of COVID-19 outbreaks in LTCFs increased sharply as Taiwan experienced a large community outbreak of COVID-19 predominantly affecting the Taipei metropolitan area during May to July 2021. The aims of this study were to describe the epidemiological data on the extent and impacts of the COVID-19 outbreaks on LTCFs in Taiwan during May to July 2021, analyze the differences between LTCFs with and without COVID-19 outbreaks, and compare the characteristics of infected staff members and residents of the LTCFs affected by the outbreaks.

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# Methods

## Study design and setting

We conducted a nationwide retrospective population-based cohort study of all COVID-19 outbreaks in Taiwanese LTCFs, including 539 skilled nursing homes and 1079 senior assisted living facilities, from May 15 to July 31, 2021. In Taiwan, COVID-19 was classified as a notifiable communicable disease on January 15, 2020. All suspected patients were reported to the Taiwan Centers for Disease Control (CDC), Ministry of Health and Welfare, through the National Infectious Disease Reporting System (NIDRS) within 24 hours.[14] Once a patient with suspected COVID-19 in the LTCF was found to have confirmed disease status by reverse transcription polymerase chain reaction (RT-PCR), local public health departments, in collaboration with stakeholders, conducted an epidemiologic investigation according to the guidance[15] developed by the Taiwan CDC. When a COVID-19 outbreak was confirmed in the investigation, the facility would promptly implement the contingency protocol as per the CDC's guidance and under the supervision of the public health department to mitigate the outbreak. In brief, the containment measures included facility-wide screening testing, isolation of confirmed cases, quarantine of close contacts, cohort care of residents based on the assessment of the risk of exposure, suspension of new resident admissions, and visitor restrictions. If no more confirmed cases were identified for 14 days since the last confirmed patient in the facility, the public health department would declare the end of the outbreak and issue an outbreak report.

## Ethical statement

This study was conducted according to the protocol (no. TwCDCIRB109206, date of approval on 6th September 2021) and approved a priori by the institutional review board (IRB) of Taiwan CDC. The IRB waived the requirement of informed consent because of the

retrospective nature of the study.

**Definitions**

A confirmed case was defined as an individual with a positive RT-PCR result for SARS-CoV-2. We classified confirmed patients into two groups: staff and residents. A COVID-19 outbreak was defined as two or more confirmed cases with an epidemiological link, and at least one confirmed case of acquired infection in the facility deemed by the investigation team. A primary case of an outbreak was defined as a confirmed case who was suspected to initiate the subsequent spread of SARS-CoV-2 transmission in a LTCF. Delayed period of identification was defined as the duration from the date of symptom onset in a symptomatic patient to the date of the first positive RT-PCR result. The 30-day all-cause mortality was defined as death occurring within 30 days after the date of symptom onset in a symptomatic patient or the date of specimen collection of the first positive RT-PCR result from an asymptomatic patient. Outbreak duration was defined as the duration from the date of the first positive RT-PCR result recorded for the primary case to the last confirmed case in an outbreak. We classified the vaccination status of confirmed patients into three categories: fully vaccinated, partially vaccinated, and unvaccinated. A fully vaccinated patient was defined as an individual for whom 14 days had elapsed since receiving a primary series of two doses of the COVID-19 vaccine. A partially vaccinated patient was defined as an individual for whom 14 days had elapsed since receiving the first dose of the COVID19 vaccine in a two-dose series. The patients who did not meet the definitions of fully or partially vaccinated patient were deemed unvaccinated.

**Data collection**

The data on ownership, total beds, and location of skilled nursing homes and senior assisted living facilities were derived from the Medical Affairs System[16] and senior assisted living facility register database,[17] respectively. Data on occupancy rates of LTCFs were obtained from the Long-term Care Institution Infection Control Inspection Information System.[18] We obtained the demographics, characteristics, and test results of the confirmed cases from the NIDRS. We retrieved information regarding the symptoms, occupation, and extent of outbreaks from the outbreak investigation reports. We acquired the vaccination status of the confirmed cases from the National Immunization Information System.[19] We obtained the date of death by linking the unique identification number of confirmed cases with the NIRDS, National Death Registry, and National Health Insurance databases.[20]

**Statistical analysis**

Categorical variables were compared using the chi-squared test or Fisher's exact test, and continuous variables were compared using parametric or nonparametric tests. We compared the characteristics between facilities with and without outbreaks using multivariate logistic regression. We performed both univariate and multivariate survival analyses using the Cox regression model to determine the hazard ratios (HRs) and 95% confidence intervals (CIs) for 30-day all-cause mortality. Statistical analyses were performed using R.4.1.0 (R Core Team, R Foundation for Statistical Computing, Vienna, Austria).

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## Results

From May 15 to July 31, 2021, 16 LTCFs, 11 (2.0%) out of 539 skilled nursing homes, and 5 (0.5%) out of 1,075 senior assisted living facilities, reported outbreaks of COVID-19, with a total of 269 cases, and median of six cases (interquartile range [IQR], 2–31) per outbreak. According to the dates of RT-PCR confirmation in chronological order, the number of domestic cases of COVID-19 in Taiwan has remained at a very low level since early 2020, and a sharp rise in cases began in May 2021, with a maximum of 3365 newly diagnosed cases in a week (Figure 1). Surges in LTCF outbreaks coincided with increases in domestic case numbers. Since the start of the COVID-19 pandemic in early 2020, the Central Epidemic Command Center (CECC) of Taiwan has implemented multi-pronged infection control policies for LTCFs, including symptom-based surveillance, enforced hand hygiene, visitor restriction, and universal masking (Fig. 1). In response to the progressing COVID-19 epidemic in Taiwan in May 2021, more infection control policies were added, such as universal testing for all newly admitted residents and suspended social visits. The wave of the community epidemic regressed by the end of July 2021.

Among the 16 LTCFs with COVID-19 outbreaks, 13 (81.3%) were privately owned, 12 (75 %) had ≥50 beds, and the mean occupancy rate was 84.1%. Compared with 1,602 LTCFs without outbreaks reported, a high proportion of LTCFs that were publicly funded (3 [18.8%] vs. 75 [4.7%], $P < 0.01$), with a large size (total bed, ≥50) (12 [75.0%] vs. 526 [32.8%], $P < 0.01$), with an occupancy rate of <80% (6 [37.5%] vs. 262 [16.4%], $P < 0.05$), and LTCFs located in Taipei metropolitan area (8 [50.0%] vs. 405 [25.3%], $P < 0.05$) reported outbreaks. In the multivariable analyses, LTCFs with total beds ≥ 50 (adjusted odds ratio [aOR] 6.3, 95%CI, 1.9–21.1, $P < 0.01$) and LTCFs located in Taipei metropolitan area (aOR 4.6, 95%CI, 1.7–12.8, $P$ value < 0.01) were significantly associated with COVID-19 outbreaks.

The median duration of the 16 outbreaks was 8.0 (IQR, 1.0–30.3) days, with a median outbreak size of 6.0 (IQR, 2.0–31.3) cases. Excluding two outbreaks without available attack rates, the median attack rate among the 14 outbreaks was 14.4% (IQR, 4.0–55.8%) of the total residents and facility staff. Among the 269 LTCF outbreak-associated COVID-19 cases, 100 (37.1%) cases were reported in four (25%) outbreaks initiated by staff cases with a median outbreak size of 25.5 cases (IQR, 16.5–34.0) and a median duration of 20.0 (13.3–23.3) days. In 12 (75.0%) outbreaks initiated by resident cases, the median outbreak size was 2.5 (IQR, 2.0–24.5) cases, and median duration was 6.5 (4.0–16.0) days. The 269 LTCF outbreak-associated cases accounted for 2.0% of the 13,377 confirmed cases nationwide during the study period, with a median age of 69 years (IQR, 54–83). The characteristics of confirmed cases are presented in Table 1. Among the 66 (24.5%) staff cases, the majority (47 [71.2%]) were resident care attendants, followed by nurses (9 [13.6%]) and administrative assistants (7 [10.6%]). Only two (3.0%) of the staff cases worked across multiple LTCFs, and none of the two staff cases caused subsequent COVID-19 outbreaks in other LTCFs where they worked concomitantly. Only 9 (3.4%) out of 269 cases received one dose of the COVID-19 vaccine in a two-dose primary series.

The 30-day all-cause mortality of the 269 cases was 24.2% (65/269), and all 65 deaths were resident cases. The 65 deaths accounted for 13.2% of the 492 deaths of confirmed COVID-19 cases nationwide during the study period. Stratifying the 30-day all-cause mortality by age, the mortality rates for patients aged between 65 and 79 and aged ≥ 80 years were 26.0% (19/73) and 43.3% (39/90), respectively, and both were significantly higher than the rate for patients aged <65 years (6.7%, 7/106) ($P < 0.01$) (Table 2). Multivariable analyses showed that 30-day all-cause mortality of patients with COVID-19 affected in LTCF-associated outbreaks was significantly associated with age ≥65 years, presence of symptoms present upon diagnosis, and LTCFs occupancy rate of ≥80% ($P < 0.01$).

## Discussion

This national study presents findings on COVID-19 outbreaks in LTCFs in Taiwan. LTCFs provide care to the elderly and people with disabilities requiring residential care, many of whom have multiple comorbid diseases and depressed immunity. The vulnerability of LTCF residents disposes SARS-CoV-2-infected residents to a high risk of poor outcomes.[2-4] The majority of COVID-19 outbreaks in LTCFs were identified in northern Taiwan, which was the epicenter of community transmission during the study period.[21] The community transmission of COVID-19 was a strong predictor of COVID-19 cases being identified in LTCFs, which could lead to outbreaks.[5,7,9] Our study also revealed that a larger facility size with ≥50 beds was associated with the risk of a COVID-19 outbreak, which is consistent with the results of other studies.[5-8] Large facilities might have more residents and working staff than small ones, resulting in more person-to-person encounters within facilities and more interactions between facilities and community, which would increase the possibility of infections introduced into LTCFs and facilitate transmission within facilities, especially in communities with high COVID-19 prevalence.

The prognosis of COVID-19 was significantly worse for the residents, especially for older residents, than for the staff. The 30-day mortality of the residents in this study was 32%, and no infected staff member died, which is similar to the results reported in other studies.[2,3,12] Aging has been recognized as a risk factor for mortality in patients with COVID-19.[2,6,22] Although we did not assess the underlying conditions of the confirmed cases, it is reasonable that the 30-day mortality for the resident cases was higher than that for the staff cases, considering the more advanced age and more comorbidities in the residents. In addition to the vulnerability of the residents, group living arrangements in these institutions also increase the risk of transmission of infectious diseases and poor prognosis.[3,4,11] The residents at LTCFs were found to be at a higher risk of mortality due to SARS-CoV-2

infections than their community-living counterparts after adjusting for relevant personal comorbidity factors.[3,4] David et al. reported that the incidence rate ratio of COVID-19-related deaths among LTCF residents aged ≥70 years was approximately 13 times higher than that of COVID-19-related deaths among their community-dwelling counterparts.[4] The common characteristics of LTCF operations, such as crowding, use of communal space, low staffing ratio, high care need, and difficulty in adherence to instructions by physically or mentally disabled residents, have been recognized as important drivers of susceptibility to outbreaks in LTCFs and increased mortality of infected residents.[3,4,11,12] In our present study, the SARS-CoV-2-infected residents in LTCFs with an occupancy rate of ≥80% were at a three-fold higher risk of mortality than infected residents in LTCFs with an occupancy rate of <80%. A similar association was also observed in a study that examined the characteristics of nursing homes in Connecticut, New Jersey, and New York where residents died from COVID-19.[23] A high occupancy rate implies a high workload and low staffing, which might consequently compromise adherence to IPC measures and impair the care quality of staff.

LTCF staff were usually at the interface between LTCFs and the community and, thus, were an important vector for introducing SARS-CoV-2 in LTCFs. According to previous studies, approximately 8–16% of such outbreaks were identified as being initiated by a staff case,[3,6,24] and the index case was identified as a staff member in up to 25% of the outbreaks in our study. In addition, considering the greater mobility and connectedness of the staff than that of the residents, they play a key driving role in transmitting the infection to each other and to residents. Hence, it can be said that outbreaks initiated by staff cases involved broader extents with more secondary cases and spanned longer durations than outbreaks initiated by resident cases, although the differences were not statistically significant. Therefore, infection prevention and control strategies for LTCFs should address measures for staff management, including sickness leave provisions, workforce mobility, access to PPE, vaccination, and

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routine testing.[5,7,10,11]

Vaccination is an important pharmaceutical measure for protecting LTCF residents from COVID-19 by reducing the risk of infection and severe outcomes.[9-11] A national observational study conducted in Germany revealed that large-scale full vaccination coverage of LTCFs was negatively associated with weekly numbers of COVID-19 outbreaks.[9] Nevertheless, the national COVID-19 vaccination campaign for LTCF staff and residents was implemented in week 17, 2021, approximately four weeks before the onset of the 2021 large community COVID-19 outbreak. Therefore, reinforcement of infection prevention and control practices is of utmost importance to protect the vulnerable residents of LTCFs when pharmaceutical interventions are not widely available.[1,7,9]

However, COVID-19 presents considerable infection control challenges in LTCFs owing to the significant infectivity of SARS-CoV-2 prior to the onset of symptoms.[2,12] Symptom-based screening will likely fail to identify asymptomatic or pre-symptomatic individuals and consequently result in widespread transmission. The proportion of asymptomatic or pre-symptomatic SARS-CoV-2 infections in LTCFs varied from 7% to 69% according to investigations with different study designs.[2,5,7] Therefore, a test-based strategy for the early detection of asymptomatic and pre-symptomatic cases in LTCFs has been proposed as a mitigation measure to contain COVID-19 outbreaks in LTCFs.[7,10-12] The relatively higher proportion of asymptomatic cases, approximately 60%, and lower median outbreak size in our study than that in other studies[3,9] might be partially due to the infection control policy of rapid facility-wide and serial testing at the first sign of outbreaks in LTCFs for early identification of potentially infected patients.[13] Early identification of infections might help facilities contain potential outbreaks by prioritizing IPC recommendations and rapid isolation of infected cases, resulting in fewer transmissions than would occur when relying on symptom-based surveillance.

Our study had several limitations. First, contact tracing was overwhelmed during the peak of the large 2021 community outbreak. In many LTCF outbreaks, the sources of the initial transmission are difficult to determine. However, an investigation was performed in each outbreak, as it occurred in LTCFs. The source of infection and the transmission chain were still identified as clear as possible. Second, we did not assess the cause of death individually and might have misclassified the cause of death. Nevertheless, it is reasonable to assume that COVID-19 accounted for most of the deaths among those who died within 30 days after diagnosis. Finally, the occupancy rates of LTCFs were acquired in August 2021 and may have had some bias regarding the exact occupancy rates at the time of the community epidemic.

In conclusion, the residents of LTCFs are one of the most susceptible groups to SARS-CoV-2 infection owing to their vulnerability and specific characteristics of LTCFs. The introduction of COVID-19 in LTCFs can be catastrophic, leading to outbreaks in facilities and fatal outcomes for residents. Staff with COVID-19 might not have as poor outcomes as the residents with COVID-19, but they could be an important vector of SARS-CoV-2 within facilities and contribute to large outbreaks. Therefore, multi-pronged infection control practices and strategies to ensure adequate staffing should be implemented in addition to pharmaceutical interventions to contain COVID-19 outbreaks in LTCFs.

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## Conflict of interest statement

None declared.

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| Cases | HCWs (n=66) | Residents (n=203) | Total (n=269) | *P* values |
|---|---|---|---|---|
| Age | 40 (34–46) | 77 (66–85) | 69 (54–83) | < 0.01 |
| Sex, female | 59 (89.4) | 98 (48.3) | 157 (58.4) | < 0.01 |
| Symptom status[a], asymptomatic | 35 (53.0) | 125 (61.6) | 160 (59.5) | 0.22 |
| Delayed period of identification[b] | 1.0 (1.0–3.0) | 1.0 (0.0–2.0) | 1.0 (0.0–2.0) | 0.04 |
| 30-day all-cause mortality | 0 (0.0) | 65 (32.0) | 65 (24.2) | < 0.01 |
| Facility type | | | | |
| Senior assisted living facility | 28 (42.4) | 93 (45.8) | 121 (45.0) | 0.63 |
| Skilled nursing home | 38 (57.6) | 110 (54.2) | 148 (55.0) | |
| COVID-19 Vaccine status[c] | | | | |
| Fully vaccinated | 0 (0.0) | 0 (0.0) | 0 (0.0) | |
| Partially vaccinated | 22 (33.3) | 10 (4.9) | 32 (11.9) | < 0.01 |
| Unvaccinated | 44 (66.7) | 193 (95.1) | 237 (88.1) | |

**Table 1** Demographics of COVID-19 cases in long-term care facilities with outbreaks in Taiwan from May 15 to July 31, 2021.

a. Symptom status at the date of the first positive reverse transcription polymerase chain reaction (RT-PCR) results.

213 b. Duration from the date of symptom onset to the date of the first positive RT-PCR result. Only symptomatic patients were included in the
214 analysis.
215 c. A person was deemed fully vaccinated if 14 days had elapsed since the receipt of the complete COVID-19 vaccination series or partially
216 vaccinated if 14 days had elapsed since the receipt of the first dose of the COVID-19 vaccine in a two-dose series.
217 Abbreviation: COVID-19 = coronavirus disease 2019; HCW = healthcare worker.
218 Values are presented as median (interquartile range) or N (%).
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| | N | Deceased (%) | Crude HR | | Adjusted HR[a] | |
|---|---|---|---|---|---|---|
| | | | HR (95% CI) | *p* value | HR (95% CI) | *P* value |
| Age (years) | | | | | | |
| <65 | 106 | 7 (6.7) | Reference | | Reference | |
| 65-79 | 73 | 19 (26.0) | 4.4 (1.9–10.5) | < 0.01 | 4.3 (1.7–10.5) | < 0.01 |
| ≥80 | 90 | 39 (43.3) | 8.3 (3.7–18.5) | < 0.01 | 8.2 (3.7–18.5) | < 0.01 |
| Symptom status[a] | | | | | | |
| asymptomatic | 160 | 30 (18.6) | Reference | | Reference | |
| symptomatic | 109 | 35 (32.1) | 1.8 (1.2–3.0) | 0.01 | 2.2 (1.3–3.7) | < 0.01 |
| Sex | | | | | | |
| Male | 112 | 33 (29.5) | Reference | | Reference | |
| Female | 157 | 32 (28.4) | 0.7 (0.4–1.1) | 0.10 | 0.8 (0.5–1.4) | 0.48 |
| Ownership of relevant facilities | | | | | | |
| Private | 245 | 4(16.7%) | Reference | | Reference | |
| Government-funded | 24 | 61(24.9%) | 0.6 (0.2-1.77) | 0.39 | 1.3 (0.4-4.0) | 0.68 |
| Total bed of facilities | | | | | | |

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| | | | | | | |
|---|---|---|---|---|---|---|
| <50 Beds | 119 | 35(29.4%) | Reference | | Reference | |
| ≥50 Beds | 150 | 30(20.0%) | 0.6 (0.4-1.0) | 0.06 | 1.07 (0.5-2.3) | 0.86 |
| Occupancy rate of facilities | | | | | | |
| <80% | 89 | 13(14.6%) | Reference | | Reference | |
| ≥80% | 180 | 52(28.9%) | 2.2 (1.2-4.0) | 0.01 | 3.04 (1.3-7.4) | 0.01 |

**Table 2** Multivariable analyses for 30-day all-cause mortality of COVID-19 cases in long-term care facilities outbreaks in Taiwan from May 15 to July 31, 2021.

[a] Symptom status at the date of first positive reverse transcription polymerase chain reaction result.

Abbreviation: CI, confidence interval; HR, hazard ratio.

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225 **Figure 1** Epicurves of COVID-19 cases in the community and LTCF outbreaks by diagnosis week and infection prevention strategies for LTCFs
226 in Taiwan from week 4, 2020 to week 31, 2021.

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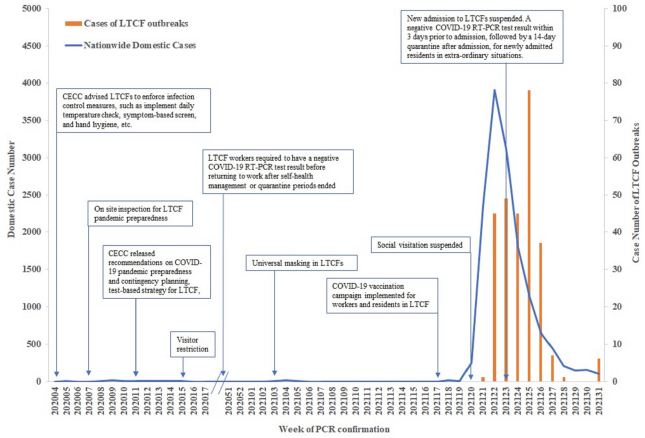


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